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A handbook to guide and direct educators in New York State in understanding, selecting, utilizing, and evaluating teaching machines and programed learning materials is presented.

The following areas are included: Administration -- guidelines for the administration in achieving the goal of effective, meaningful use of programed instruction; Programs and Programing -- preparation for the introduction of programing into a school district, responsibility for program selection, and the selection of programs for classroom use; Teaching Machines and Programed Texts -- the characteristics, educational standards, program and frame evaluation, technical standards of programed texts and teaching machines, and the testing of programs before classroom use; Utilization in the Classroom -- the utilization of programed material, preparation before using the program, principles of use of the program, and follow-up activities after using the program.

Also given are definitions of programed instruction and teaching machines; selected reading including a bibliography, a bibliography of media, and supplementary references; a glossary of terms and the Technological Development Project (TDP) Glossary; a directory of publishers and manufacturers; and appendices.

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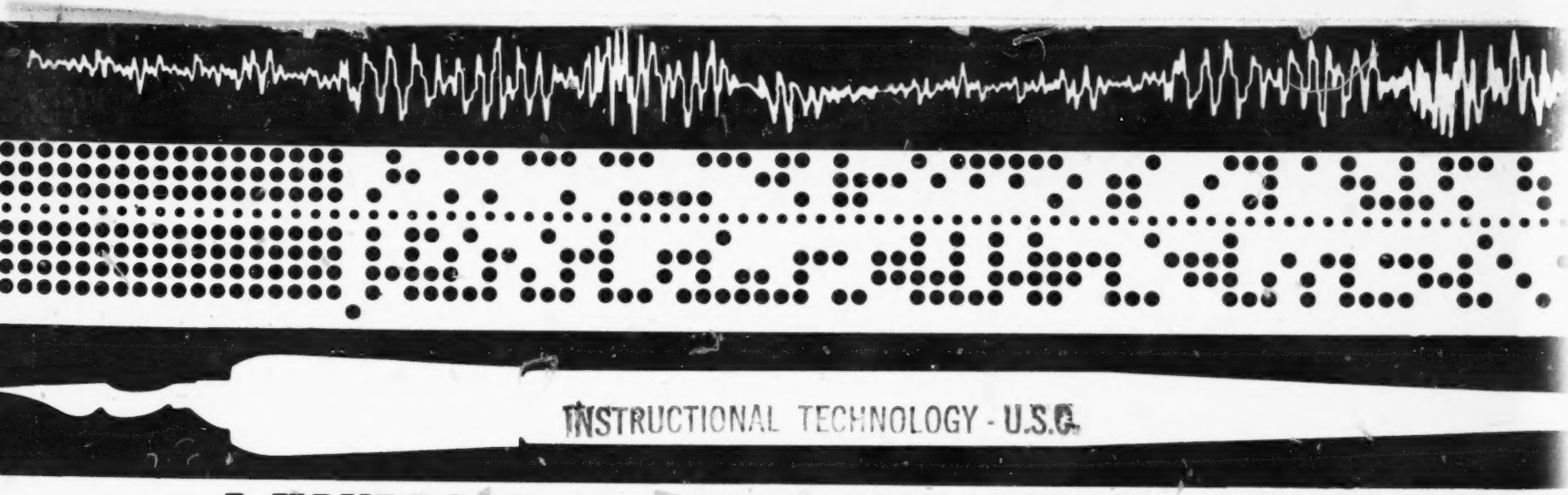

INSTRUCTIONAL TECHNOLOGY - U.S.C.

A HANDBOOK OF PROGRAMED LEARNING INFORMATION

ED002205

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U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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The cover of this publication has been designed to express the entire range that the process of programing instruction covers. The symbolism of mass communication, computer technology and the written word signifies the medium concerned, and its contribution and role in educational technology and communications.

A HANDBOOK OF PROGRAMED LEARNING INFORMATION

PREPARED BY

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Associate in Educational Communications

The University of the State of New York
The State Education Department
Albany, New York 12224

April 1, 1964

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FOREWORD

This Handbook on Teaching Machines and Programed Learning was prepared to guide and direct educators in New York State in understanding, selecting, utilizing, and evaluating teaching machines and programed learning materials.

The information presented in the Handbook was culled from a wide variety of sources, activities, and professional personnel. Since 1958, the field of teaching machines and programed learning has literally been flooded with printed reports and information of all kinds. Conferences, meetings and workshops have been held locally, on a national basis, and even on an international basis. In this short period of time, relatively vast amounts of research data have been accumulated. Not since 1953, when educational television entered the instructional technology scene, has an idea grasped the imagination of the educator to the extent which teaching machines and programed learning have succeeded in doing.

As the result of the continuing interest and acceptance of programed learning, Mr. William F. Ryan, an Associate in Educational Communications in the Bureau of Classroom Communications, was assigned the task of preparing a handbook for educators in the State of New York. Mr. Ryan visited schools and colleges, speaking to those actively engaged in programed learning activities. He attended professional conferences held by the American Educational Research Association, the American Psychological Association, the National Education Association's Department of Audio-Visual Instruction, and the National Society for Programed Instruction. Mr. Ryan was in constant contact with the Center for Programed Instruction, regional program instruction associations, and military and industrial organizations. This publication is the result of his varied activities and contacts.

The Handbook recognizes programed instruction as relatively new and thus far largely experimental. However, it is the belief of the Division of Educational Communications that it is practical and advisable to introduce programed instruction media and materials into the curriculum at this time subject to such principles as outlined in this publication. To assist educational institutions in doing this, the Division stands ready to participate by providing the services outlined in this Handbook.

Lee E. Campion

Director

Division of Educational Communications

CHAPTER I

DEFINITIONS

The definition of terms has been, and is, a problem in the communications field. This has been evidenced in a recent DAVI-NEA publication entitled "The Changing Role of the Audiovisual Process in Education: A Definition and a Glossary of Related Terms," which was the first major attempt to provide a taxonomy in the educational communications field. Hence, it seems particularly appropriate to begin this handbook with a statement of what we are going to consider as programed learning and teaching machines.

Programed Instruction - The utilization of programed materials in achieving educational objectives.[1]

To produce optimal learning, the following elements of programed instruction must be present.[2]

1. Active response by the student.
2. Small steps in which careful control of stimuli produces gradual increments in mastery of the subject.
3. Immediate feedback for each response.
4. Self-pacing or rate individualization at which the learner masters the material.
5. Low error rate for the individual learner as a consequence of the effective operation of items 1-4 above.

Teaching Machines - Devices that house, display and present instructional programs. Provisions for suitable responses on the part of the student and tutorial feedback must be present. By these criteria, audiovisual aids, as well as simulators and other devices, although they might be machines used in teaching, do not qualify as teaching machines.

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[1]See Glossary #2, reprinted from Monograph #1, the Changing Role of the Audiovisual Process: A Definition and a Glossary of Related Terms for further refinements of this definition.

[2]The material on this page is presented as a summary of the definitions provided in the NDEA Policy Bulletin, Series III, Number 13, June 12, 1963. The bulletin concerns itself with federal financial participation under Title III of the National Defense Education Act in the cost of programed learning materials and teaching machines. Further information and guidance is presented throughout the remainder of this handbook.

Teaching Machines (Continued) - Teaching machines may or may not score responses or tally errors. With constructed response programs, the evaluation of the answer and error analysis must be left to the student pending the feasible development of optical scanning and mechanized semantic analyzers.

CHAPTER II

SELECTED READINGS

Since the introduction of the programing concept for classroom instruction, a voluminous amount of written material has been published. The following listing, though not exhaustive, contains valuable reference material and resource information. The selected list is representative of the several texts, research materials and programing literature available. Many of the references below contain more extensive listings of programed instruction material.

A. Selected Bibliography

Coulson, John E., "Programed Learning and Computer-Based Instruction," New York: John Wiley and Sons, Inc. 1962. 291 pp.

Cramm, David, "Explaining Teaching Machines and Programing," San Francisco: Fearon Publishers, 1961. 86 pp.

Deterline, William A., "An Introduction to Programed Instruction," Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962. 131 pp.

Finn, James D., and Perrin, Donald G., "Teaching Machines and Programed Learning, 1962: A Survey of the Industry," Washington, D.C.: National Education Association, 1962. 85 pp.

Finn, James D., Perrin, Donald G., and Campion, Lee E., "Studies in the Growth of Instructional Technology, I: Audio-Visual Instrumentation for Instruction in the Public Schools, 1930-1960, A Basis for Take-Off," Washington: National Education Association.

Fray, Edward B., Bryan, Glenn L., and Rigney, Joseph. "Teaching Machines: An Annotated Bibliography," Washington, D.C.: Department of Audio-Visual Instruction, National Education Association, 1960. 80 pp.

Fry, Edward, "Teaching Machines and Programed Learning: An Introduction to Autoinstruction," New York: McGraw-Hill Book Company, 1963. 244 pp.

Galenter, Eugene H., (Ed.), "Automatic Teaching: The State of the Art," New York: John Wiley and Sons, 1959. 198 pp.

Hendershot, Carl, "Programed Learning and Teaching Machines Summary," Delta College, University Center, Michigan, 1963.

Leavitt, Jerome E., and Edgar, Rille J., "Programed Learning and Teaching Machines - Part I," bibliography. Salem, Oregon: Instructional Services Section, State Department of Education, June 1961.

Lumsdaine, Arthur A., and Glaser, Robert, (Eds.), "Teaching Machines and Programed Learning: A Source Book," Washington, Department of Audio-Visual Instruction, National Education Association, 1960. 724 pp.

Lysaught, Jerome P., and Williams, Clarence M., "A Guide to Programed Instruction," New York: John Wiley & Sons, 1963. 180 pp.

Mager, Robert F., "Preparing Objectives for Programed Instruction," San Francisco: Fearon Publishers, 1962. 62 pp.

Margulies, Stuart, and Eigen, Lewis D. (Eds.),"Applied Programed Instruction," New York: John Wiley and Sons, 1962. 387 pp.

Markle, Susan Myer, Eigen, Lewis D., and Komoski, P. Kenneth, "A Programed Primer on Programing," Vol. 1, 2nd Edition, New York: The Center for Programed Instruction, Inc., 1961. 28 pp.

Markle, Susan Meyer, "A Programed Primer on Programing," Vol. II, 2nd Edition, New York: The Center for Programed Instruction, Inc., 1961. 44 pp.

Schramm, Wilbur, "Programed Instruction, Today and Tomorrow," New York: The Fund for the Advancement of Education, November, 1962. 74 pp.

Stolurow, Lawrence M., "Teaching by Machine," Washington: U.S. Department of Health, Education and Welfare, Office of Education, 1961. 173 pp.

B. Bibliography of Media

The following films and filmstrips are available on short term loan from the Teaching Machine and Programed Learning Project of the Bureau of Classroom Communications, State Education Department, Albany 1, New York. The purpose of these films and filmstrips is to present basic information to personnel who want to learn about programing, and who wish to use programs in their work. In some films, the actual teaching devices are outdated, however, the examples illustrating the usage of the devices remain most valuable. The films are especially helpful in explaining teaching machines and programed learning to educators and laymen who are just beginning a study of this field.

Films

AUTO-INSTRUCTIONAL PROGRAMING. (Kinescope, 40 min., second, b-w), Lawrence M. Stolurow, University of Illinois. Presents the functions of programed instruction as described in the Office of Education monograph. (Office of Education Publication, No. OE 3-4010, Cooperative Research Monograph, No.6). Illustrates programed materials, and compares the use of the teaching machine and programed materials with the textbooks.

LEARNING AND BEHAVIOR (THE TEACHING MACHINE). (26 min., sound, b-w) Carousel Films. Explains the learning process, how learning and conditioning can be measured in the laboratory, and B. F. Skinner's theory of reinforcement. Produced by CBS.

ONE STEP AT A TIME. (30 min., sound, color, 16mm). American Institute for Research. Defines programed instruction, reports research findings concerning its effectiveness, and suggests possible means of using programed instruction in the schools.

A PROBING MIND. (29 min., sound, b-w, 16mm) Norwood Film. Illustrates the uses of new education media - films, television, recordings, teaching machines - and well-equipped laboratories in the teaching of high school science.

PROGRAMED LEARNING WITH A TEACHING MACHINE: DEMONSTRATION WITH THIRD-GRADE CHILDREN. (15 min., silent with captions, b-w). Lawrence M. Stolurow, University of Illinois. Shows one-half of the class working with teaching machines while the teacher works with the other half.

TEACHING MACHINES AND PROGRAMED LEARNING. (29 min., sound, b-w, 16mm). National Education Association, DAVI. Presents B. F. Skinner explaining the theory of programed learning, Arthur Lumsdaine describing a variety of teaching machines and programed materials, and Robert Glaser discussing the implication of such machines and materials for education.

Filmstrips

AN EXAMPLE OF A TEACHING MACHINE PROGRAM. (62 frames, color) Basic Skill Films. Shows an example of a program on how to read the color code on resistors.

TEACHING MACHINES. (62 frames, color) Basic Skill Films. Gives a general overview of programing.

The following three films, also available from the Bureau of Classroom Communications, furnish background information in the theory of learning as applied to programed instruction.

Films

CONTROLLING BEHAVIOR THROUGH REINFORCEMENT, 16mm, sound, black and white, McGraw Hill Films, 1963. This film shows that by reinforcing an organism on different schedules, we can control not only how fast it works at any given time, but also the way it distributes that work within a given period of time. These results are demonstrated with pigeons under controlled laboratory conditions, and in an elementary classroom where we watch the varying results of putting the children on different reinforcement schedules. Script written in collaboration with K.C. Montgomery, Department of Psychology, Yale University. Technical advisers on pigeon scenes: Richard J. Herrnstein and William H. Morse, Department of Psychology, Harvard University. (16 minutes, $95.)

LEARNING DISCRIMINATIONS AND SKILLS, 16mm sound, black and white, 16 minutes. McGraw Hill Films, 1963. In a detailed analysis of the learning process, this film demonstrates that the learning of a skill by an organism involves two basic and closely integrated processes: Discrimination between stimuli, and application of this discrimination in the making of selected responses. Laboratory experiments with pigeons are shown in the demonstration.

REINFORCEMENT IN LEARNING AND EXTINCTION, 16mm, sound, black and white, 8 minutes. McGraw Hill Films, 1963. In this film, it is established that, in general, behavior that is reinforced does get learned, while non-reinforced behavior is extinguished. This principle is demonstrated in the film with both humans and pigeons.

C. Supplementary References

A. "PROGRAMS '63 - A GUIDE TO PROGRAMED INSTRUCTIONAL MATERIALS AVAILABLE TO EDUCATORS BY SEPTEMBER 1963." WASHINGTON, U.S. GOVERNMENT PRINTING OFFICE, 1963, OE-34015-63, 814 pp.

This newest edition, Programs '63, is the first half of a two-part survey of all commercially available programed material. The second part will concern itself with the "Use of Programed Instruction" in schools in the United States. Programs '62 was followed by a similar survey. This survey is listed below.

It will be noted in Programs '63 that it lists all programed materials available to educators by the fall of 1963. Samples catalogued were chosen by the publishers themselves. The editors believe that their primary obligation in Programs '63 was to indicate the number, variety and source of available programs.

The accompanying statistical chart, Appendix A, demonstrates quite clearly the large increase of programs, and the need for a reference manual such as Program '63.

"The Use of Programed Instruction in U.S. Schools." A report of a survey of the use of programed instruction materials in the public schools of the United States during the year, 1961-62, Washington, U.S. Government Printing Office, 1963, OE-34022, 83 pp.

RESEARCH AND REVIEW JOURNALS

1. Excellent journals for research articles are the Automated Teaching Bulletin (no longer printed), Journal of Educational Psychology, Journal of the Experimental Analysis of Behavior, Journal of Programed Instruction, and Psychological Reports.

2. Valuable journals for review (i.e., general) articles are: AID (Auto-Instructional Devices, now incorporated in National Society for Programed Instruction Journal), Audio-Visual Communication Review, the "Instructional Media" section of Contemporary Psychology, Programed Instruction, and Teaching Aids News Letter.

3. Miscellaneous research and review sources include other journals, local newsletters, many popular periodicals, and certain Technical Documentary Reports published by the military. For more details concerning this material, contact the Teaching Machine and Programed Learning Project.

D. "1962 INTERIM REPORT OF THE AERA-APA-DAVI JOINT COMMITTEE ON CRITERIA FOR ASSESSING PROGRAMED INSTRUCTIONAL MATERIAL."

The 1962 Interim Report of the Joint Committee on Programed Instruction on Criteria for Assessing Programed Instructional Material was prepared with the cooperation and support of the Educational Media Branch, U.S. Office of Education, under Title VII of the National Defense Education Act. The interim report appears in its entirety in the special issue of Audio-Visual Instruction, February, 1963 on Programed Instruction, pp. 84-89.

This interim report is appended to this handbook. It amplifies and extends the previous guidelines published in 1961. The report is addressed primarily to the non-technical reader interested in possible purchase of programs. It summarizes some basic aspects of the nature and current status of programed instruction, and also presents some suggestions and cautions concerning the assessment of programs.

CHAPTER III

ADMINISTRATION

The administration is charged with the vital role of guiding and unifying the efforts of an educational system in achieving the goal of effective meaningful use of programed instruction. The entire spectrum from selection of materials, through final evaluation, rests in the decisions, assistance and guidance provided by the administrator. Particular guidelines are presented:

Plan in-service training workshops or summer institutes for the faculty to fully acquaint them with the medium.

Set up an administrative program for the selection and evaluation team.

Establish an overall financial plan looking ahead to continuing programed learning.

Work cooperatively with machine manufacturers and program producers in identifying your requirements with respect to cost, flexibility, size, weight, maintainability and sound psychological methodology.

Investigate carefully a policy for granting of course or subject matter credit to students successfully completing such a programed course.

Expect school building design, curriculum, planning teacher time schedules, grade reporting and equipment budgets to be affected by use of programed instruction.

Work closely with programed learning specialists, subject area specialists and State Education Department personnel.

Consider providing time for personnel to develop programs once programed learning has established itself in your schools.

Visit other locations in your geographical area where programs and devices are being used in your area of interest. Locations of on-going activities are available from the Bureau of Classroom Communications.

Study the provisions of Title III, NDEA in reference to federal financial participation in the cost of programed instruction materials.

CHAPTER IV

PROGRAMS AND PROGRAMING

The preparation of programed material available from commercial sources has taken many hours of patience, work and revision. In the early stages of programing, publishers and commercial sources have invested considerable funds to produce program material of high quality. The supply of programs is good at this time. Personnel with skills in the art of programing are difficult to find and intensive training is required.

A serious look at the time and expense element in program construction is necessary before a school decides to have a classroom teacher prepare programs. If a school district does wish to investigate and attempt to construct their own programs, the resources of the previously mentioned "team" should be used in the development of short units.

Utilization of the services of the Division of Educational Communications, qualified consultants and training media are necessary. This handbook lists in its bibliographies many valuable text and film references for in-service training. Many institutes of higher education conduct summer and school year workshops throughout the State of New York. Time, money, skill and training will all play an important part when a school district plans to have in-service training of personnel, to experiment with their own program construction of small units.

Whether or not school personnel will be involved in actual programing, it is desirable to have this knowledge to evaluate skillfully the many commercial programs now available.

The broad general steps to be taken in the introduction of programing into a school district are as follows:

Read as much available literature as possible.

Utilize qualified consultants.

Visit educational situations where programed instruction is now in use.

Obtain sample materials for your own analysis.

Use the media services furnished by the Division of Educational Communications.

Conduct in-service workshops.

Allow trained personnel time to experiment, investigate and use programed instruction within the framework of your own district.

The more a faculty knows about programed instruction, the better the results will be. In the very near future, formal training in the selection and use of the medium will be a necessity. The trained teacher will be the best asset your district can have. The interaction between these trained personnel with the established evaluation team will be most valuable.

A. RESPONSIBILITY FOR PROGRAM SELECTION AND EVALUATION

The responsibility for program selection and evaluation is the task of a knowledgeable group of educators adequately trained in the special skills necessary to understand the unique nature of programed materials. Though some of the responsibilities will overlap on the local level, a team concept of evaluation is desirable. We have seen these responsibilities managed by different groups of specialists in varied national associations. It is this same pattern of cooperation that we encourage.

Three types of specialists are necessary - the subject area specialist, the curriculum specialist and the educational communications specialist.

The subject area specialist is responsible for all factors of content, quality control and authenticity of subject matter presented in a programed format.

The curriculum specialist is responsible for programed instruction in the overall role it plays in the total curriculum. The approaches to be taken and the adaptability of the material in terms of student needs are a prime concern of this specialist. Finally, this specialist needs to determine the methods to be adopted in terms of course units, length of time involved and any other problems that may present themselves insofar as the curriculum is concerned.

The educational communications specialist has the responsibility for selection and evaluation of material in respect to its audio-visual format. He must have the ability to perform administrative duties necessary to evaluate educational and technical specifications. He is further charged with the logistics of storage, distribution and dissemination of information and practical use of this medium. This specialist will often assume the duties of total coordination of the efforts of the selection and evaluation team.

By accepting a team concept of selection and evaluation, it is realized how vital this function is to all educators. It means that all concerned with programed instruction must be knowledgeable concerning the art of programing. Selectors and evaluators must have a reasonable knowledge of the basic theory involved. The team concept of these necessary selection and evaluation duties and performance of them will result in an effective functional group producing optimal results.

B. SELECTION OF PROGRAMS BEFORE CLASSROOM USE

With the wide variety of programed materials now available, and the understanding of the responsibilities involved, the selection of materials, prior to their actual use in the classroom is the first duty. Educators have always reviewed materials in the belief that careful selection is paramount. No single program is suitable to all objectives. All available programs in each subject area of concern should be investigated.

Publishers or individual local programers have the responsibility of providing educators with the following information.

RESEARCH DATA - Adequate reports of research and testing performed during the construction of the program should be furnished.

SUBJECT COVERAGE - The material should be categorized for grade level, semestrial equivalents or in complete units. This should be stated.

COPYRIGHT DATA - Data pertinent to publication rights, dates and location of original publication should be given.

CONTENT AUTHORITY - Resource material and content authority information listed in accurate concise form.

PHYSICAL DATA CHECK - In the check list the following information should be made available.

Mode of presentation. Is the mode of a linear, branching or other type of form.

Length of time estimated to complete the program.

Costs including accessory equipment and replacement materials.

Accompanying manual for administering the program, checking progress.

Tests supplies should be described. These descriptions should state whether the tests are diagnostic or achievement type tests.

ENRICHMENT MATERIALS - Listing of other suggested materials should accompany the programed materials. Suggestions for implementation of Program Learning activity with audiovisual media, discussion activities, etc. are most desirable.

VALIDATION - The publisher should make available statement giving results of validation testing. The inclusion of information on conditions of pretesting, procedures followed, and development in terms of revision.

It is to be emphasized that the preceding information should be available to educators before programs are purchased for classroom use.

CHAPTER V

TEACHING MACHINES AND PROGRAMED TEXTS

At this stage of development in the manufacture of programing devices, rigid standards do not seem to be possible due to the present state of development of the programing medium.

Consequently, statements of characteristics, standards, evaluation and testing are made in broad generalizations to allow for flexibilities in appraising the individual adaptability of each instructional device to particular needs.

A. Characteristics

The operating functions of teaching machines are variable. Teaching machine characteristics are evident in the method of display on the part of the learner (read-in) and method (read-out) of reinforcement indicated on the teaching device. A representative listing of these displays, "read-in" and "read-out" descriptions is given to indicate the wide range of variables used.

DISPLAYS

1. Printed Sheets
2. Printed Roller Sheets
3. Printed Cards
4. 35mm Slides
5. Filmstrips
6. Microfilm
7. Motion Picture Film 8/16mm
8. Magnetic Tape (audio)
9. Television (audio-video)
10. Phonograph

LEARNER RESPONSES

1. Multiple choice button
2. Write complete answer
3. Fill-in missing word or letter
4. Type answer
5. Pull tabs
6. Marking with special ink
7. Erase overlays
8. Plug electric probe into contact
9. Talk into microphone
10. Think response

INDICATION OF CORRECT RESPONSES

1. Colored lights
2. New question appears
3. Electric typewriter types reply
4. Comparison of learner answer with correct answer
5. Visual display on machines tells learner of correct answer
6. Audio recording stating that response is correct

B. Educational Standards

The publication of the United States Office of Education Policy Bulletin III-12, relating to federal financial participation in cost of programed materials (June 12, 1963) broadly defines the standards we accept below in the field of programed instruction.

Programed learning materials generally refer to those self-instructional materials which have clearly defined outcomes toward which a student proceeds at his own rate. These materials shall employ a pre-arranged sequence of material presented to the student in step increments, require the student to respond covertly or overtly actively at least once per step. The student is provided increment of material, confirmation and/or correction for each response a student makes.

Check the following five criteria during the selection of a teaching device:

1. Self-Instruction - Is the major portion of the instruction provided by programed learning materials without the presence of human instruction?
2. Self-Pacing - Does learning occur at learner's rate?
3. Feedback-Reinforcement - Does learner receive prompt confirmation or knowledge of his progress?
4. Active Participation - Is there interaction between machine, program and learner?

5. Content and Method - Is the subject matter sequence carefully controlled and consistent?

C. Program and Frame Evaluation

1. Do specific frames relate to general aims and specific objectives of program?
2. Are objectives set in meaningful, measurable, behavioral terms?
3. Is content up-to-date?
4. Is frame too difficult for comprehension?
5. Are responses adequate, eliciting desired behavior?
6. Is there logical sequencing between frames?
7. Is program efficient and effective in regard to:
   a. Time expended?
   b. Relationship to other media used?
   c. Meeting needs of individual students?
   d. Compatibility with other classroom activities?
   e. Compatibility with teacher objectives?
8. Is the program correctly presented in use of:
   a. Terminology?
   b. Correct programing form and/or spelling?
9. Are individual frames of the program correctly composed to elicit responses not of a "copy-frame" nature?

D. Technical Standards - Programed Text

The following recommendations are general in nature. Some of these standards are dual in nature. They may apply to a teaching machine. When selecting a well designed program for unit of study or an entire course, consideration should be given to the following:

1. Assembly: A programed text should be adequately bound in such a manner as to allow for re-use of program material. Covers of programed texts should be of durable material. Slide or masking devices in vertical format texts should be an integral part of the bound unit.

2. Expendable Material: Considerable thought should be given to purchase of programed materials requiring disposable answer units. Specially prepared answer attachments or printed material may not be necessary.

3. Size and Shape: All material should be of a form convenient for student use and manipulation. Consideration should be given to the desk and working area where material is to be used.

E. Technical Standards - Teaching Machine

Teaching machines come in various shapes, forms and sizes.[3] It is not our intention to indicate which machine is best. Whatever machine is selected, the standards below which supplement our previous recommendations for the programed text, are most important. The application of this information to planning under Title III, NDEA, as mentioned previously in the chapter on Administration is encouraged.

1. GUARANTEE: Unconditional guarantees of at least one year should be supplied on all mechanical, electro-mechanical, (battery or AC/DC), electro-optical, electro-aural devices and combinations of these.

2. CONSTRUCTION: Durability of material used in the construction of a device is important. Devices should be constructed of a durable plastic or metal material. When a cardboard device is used as a teaching machine, its construction should warrant its use for more than a one year period. All machines of an electrical nature must be safe, preferably carrying an Underwriters Laboratory approval seal.

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[3] In this classification, it is our intention to analyze the teaching machine itself. Scoring devices, self-scoring devices and ready-review devices are not to be construed as teaching machines, though these features may be acceptable when included as an integral part of a device which meets the criteria involved.

3. INSTALLATION: In addition to the necessities of the programed text previously considered, the classroom space to be used must contain adequate electrical power supply where needed.

4. STORAGE: Storage facilities must be available in cases where teaching machines are not permanently affixed to furniture in the location of use. This storage space should also be used for any type of visual or audio units to be used as an integral part of the program presentation.

F. Testing Programs Before Classroom Use

In some cases, publishers may not have supplied complete physical validation, or testing data. A decision has to be made about particular programs. This is a task to be assigned to personnel directly responsible for actual use of the material. Though the following suggestions are going to take time in the school day, they are most important. You want programs that will do the most good for students. They will help to make the most of classroom time later on by selecting a program that will be of value in this final selection activity.

1. Select no more than three typical students. Obtain information on their IQ, reading ability, school achievement, etc.

2. Administer a pre-test and diagnostic test to each of the three selected students before beginning the program.

3. Administer the program unit. Remain with the students during all phases of pre-testing, diagnostic testing, the program and post-test.

4. Administer the post-test. Use some form of short anecdotal record to make notes on student comments on all four phases no matter how irrelevant they may be. This procedure will enable you to select a program that is satisfactory, inform you of its content and any difficulties that may arise during the eventual class usage of the program.

After the necessary steps listed above have been taken, then the program is ready to use with a class.

CHAPTER VI

UTILIZATION IN THE CLASSROOM

The utilization of programed material is comparable to that of any other communication media material. Attention, on the part of the teacher should be given to preparatory steps, principles of use and follow up activities. The selection and evaluation team has completed its work. The program has been selected and the sample tested. Preparatory steps for utilization are to be noted.

A. Before Using the Program

1. Missing Skills: Any skills necessary for adequate response or performance must have been taught before the program is introduced. Reading ability level is most important.

2. Grading: The method of progress grading and terminal grading should be explained to students. They must understand they are not being tested when they work on a program.

3. Physical Facilities:

   (a) Sufficient copies of programs should be available. Programs should not be shared by students concurrently.

   (b) Access to sequence units should be available upon completion of preceding units.

   (c) Teaching devices necessary should be conveniently located in areas conducive to self-instruction and materials.

   (d) Use of other media or materials (films, slides, etc.) should be provided for as necessary.

   (e) Adequate provisions will be necessary for storage of devices and programs and expendable material used for these programs as presentation display material or answer sheets.

4. Explanation: The function of a particular device or textbook technique format should be explained to a student, i.e. its operation, simple maintenance, etc.

5. Other Teachers: It might be desirable to involve other sympathetic teachers in the subject to this field of programing.

6. Planning: More thorough unit planning and effective scheduling of horizontal enrichment activities will be necessary.

7. Preparation: Two factors are most important. (1) The in-service training of the teacher and (2) time spent on the actual programs being used orienting the educator to the most efficient use of the programing medium.

8. Consultation: The teacher should consult with the selection and evaluation team to plan classroom activities.

B. Using the Program

Preparation has been made at this point for using the program in the classroom. There are some principles of use to follow at this time. In addition to the information given below, Appendix C (page 54) of this manual details observations and judgements reached in the Title VII NDEA project, "Research to Discover Methods of Applying and Testing Machine Principles of Programing, Basic College Courses in Mathematics and English Composition for Presentation over Closed-Circuit Television."

1. Minimum space requirements should be established for each student.

2. Minimum acceptable scores on post tests must be obtained before progression to another unit is allowed.

3. Student interaction between each other will not be increased in a programing situation during time they are actually working on programs.

4. Fewer questions are going to be asked during the exposure period to programed instruction.

5. More time is going to be spent with individuals or small groups when using programed instruction than was possible with conventional instruction.

C. After Using the Program

At this stage of use, some important steps are to be considered. Now a final analysis will be made of all preceding activities recommended in this handbook.

1. Post-Testing: A test of a terminal nature should be constructed and administered. Care should be taken to see that frame items are not directly used as questions in the test.

2. Grading: A system of grading should be established and fully explained. Regular report cards may be used. If a percentage of items completed is used as a scale, and reported, the total number of items completed should be noted in comparison with the total number of items in the unit assigned. This method can be used in testing as well as in grading progress through a programed unit.

3. Feedback: The entire team concept of evaluation must demand a feedback to individual members of that team. All of the team's effort is culminated in this final report. Questions on the useful contribution of the program, effectiveness of the medium, location of the medium as a self-instructional or group instructional tool can be resolved.

4. Planning: The future use of the program should be evaluated by applying methods previously described. The types of programs may determine which units will be assigned as homework material, filed as library reference work or serve as reorientation of classroom activities.

CHAPTER VII

CONCLUSION

The future of programed instruction is most promising. Imagination, resourcefulness and adequate training in the use of this medium will result in positive benefits to all concerned. Use programed instruction. Try programed instruction in your classrooms. Ask for guidance, consultants, materials and research.

(A) Glossary of Terms

Published below is a tentative glossary of terms used in the field of programed instruction and teaching machines which was developed by students in an "Automated and Programed Learning" course offered at the University of Minnesota, Minneapolis, this past summer under the instruction of Robert Orlando, assistant professor of educational psychology. Dr. Orlando plans to further expand and refine the glossary.

ABSTRACTION - A response to a single property of a complex stimulus. Example: Response "CARNIVORE" to picture of a German Shepherd.

ACCESS TIME - Amount of time elapsed in getting to an item in a program. This time is used in computer terminology as the amount of time it takes the machine to search for a particular bit of information and produce it.

ADAPTIVE TEACHING MACHINE - Refers to teaching machines which automatically alter the instructional presentation sequences as a function of the pupil's performance. Example: The machine may shift to a smaller step size if the pupil is making more than four incorrect responses out of every ten frames.

ADAPTIVITY - The capacity of the teaching machine and its associated program to adjust, in one or more ways on the basis of the learner's responses, to his specific needs.

ADJUSTED-LEARNING METHOD - (see BRANCHING).

ASYNCHRONY - A method of presenting items in which (a) a changing stimulus requires the same responses or (b) a fixed stimulus requires changing responses.

Example of (a)
5 ∤ 3 = 8
6 ∤ 2 = 8
7 ∤ 1 = 8

Example of (b)
8 - 6 = 2
8 - 7 = 1
8 - 5 = 3

AUGMENTING - A programing technique which builds a new concept or complex set of relationships by serially introducing bits of information in such a way that each is related to the other. Example: "John is not a woman." "A human that is not a woman is a man." "John is a man." "John will die." "John is a person." "People who die are mortal." "John is a mortal." "John is a mortal man."

AUTOTUTOR MARK II - A brand name for a teaching machine produced and sold by U. S. Industries, Incorporated.

BINARY FRAME SELECTION - The simplest form of branching. There are at most only two alternative routes at any point in the program.

BRANCH - Any one of the alternative routes in a branching or intrinsic program.

BRANCHING - A style of programing in which selection of the next frame to be presented depends on the response given in the current frame. Example I: If an incorrect response is given, the following frame will consist of material which explains in detail why the given response is not correct, whereas if the original response is correct, the next frame presented consists of the next item in the sequence of subject matter. Example II: In a program designed to handle neurotic fears, the question "Which are you more afraid of, dogs, bears, or snakes?" could appear in one frame. Depending on the answer given (dogs, bears, or snakes), the program in the next frame directs the user to one of three sequences.

CARTESIAN METHOD - An approach to handling complex problems which may be useful in programing subject matter. It involves essentially two activities: (a) Breaking the problem into its smallest parts, and (b) proceeding from the simple to the complex.

CHOICES - Refers to the selection of an answer from several alternatives presented to the subject as opposed to having the subject construct or write out an answer.

CLASS-DESCRIPTIVE METHOD - A method of sequencing material on a program in which the common and significant characteristics of a set of objects are simultaneously presented to the learner. (This is in contrast to the object-descriptive method.) Example: The heads of three different coins are presented side by side as one display, the tails of the coins as another display.

COLLATOR - Component of a teaching machine which measures and records the learning process by collecting and recording data such as the number of errors, the type of error, time intervals required for response, etc., in such a way that each item is collated with the part of the program to which it pertains.

COLLATOR-RECORDER - The component of a teaching machine which records number of errors, type of error, response latency, etc., by frame number.

COMPARATOR - Component of a teaching machine which judges the "correctness" of the pupil's response. This evaluation is then transmitted, depending on the mode of operation, to the pupil, the reinforcement dispenser, the collator, and/or the sequence control unit.

CONFIRMATION SEQUENCE - A sequence in which the learner (a) sees the cue-stimulus, (b) makes the response, and (c) sees the confirmation. This is typical of a memory drum.

CONSTRUCTED RESPONSE - A response which is chosen from a virtually unlimited number of alternatives, based on the student's past experience. The response, however, may be limited to a general type, such as, words or numbers. This is contrasted with a response to a multiple choice question.

CONSTRUCTION - The process of requiring the subject to write out or prepare an answer as opposed to choosing one of several alternative answers.

COPYING FRAME - A type of frame which uses the "copying" programing technique to elicit the correct response under appropriate conditions. The pupil merely duplicates the response portion of the frame, which is given in full.

CORRECTION PROCEDURE - Under correction procedure a pupil is required to make a correct response to a frame before he is permitted to continue.

CRITERION PROGRAMING - The subject matter is not programed; instead, programed instructions direct the student to resource materials from which he returns for a test of the material (criterion test) and his next instructions.

CUE STIMULUS - The material (problem statement) which precedes the blank in a frame. The task of the learner is to make the correct response to the cue-stimulus.

CUMULATIVE DENSITY - The density of any portion of a program in its relation to materials which have been presented in preceding lessons.

CUTBACK-PAGE BOOKLET - A booklet designed with each succeeding page narrower than the preceding one. An answer sheet is placed under the smallest page so that its right edge extends beyond the rest of the text, providing blanks for responding to frames in the text. The correct answers are printed on the answer sheet in a position such that the frames to which the answers belong are on a page above the answer sheet which must be turned to expose the answers.

DENSITY - The rate at which new material is introduced. It is the ratio of the number of different responses required of the learner

to the total number of responses required. Independent for a single set of frames and cumulative for a sequence of sets. All different responses have a density of 1.00.

DIFFERENTIAL PROGRAMING - In differential programing, variation in the program is a function of pupil characteristics.

DISPLAY - Presentation of subject-matter information to the learner by a teaching machine. May utilize visual, auditory, tactual communication channels, or combinations of these.

DISPLAY MECHANISM - The unit of a teaching machine which presents the content material in a series of frames.

DOVETAILING - A technique used in programing which involves the interlacing of associations into a pattern consistent with that required when the information concept or skill is put to use. Example: "If $5x5 = 5^2$, and $7x7x7 = 7^3$, NxN = _____?"

DROP-OUT - Feature of a teaching machine constructed so that when the student responds appropriately to a given frame, that frame is omitted on subsequent repetition of the program.

ERROR - An incorrect or non-appropriate answer to a specific item in the program.

ERROR RATE - Refers to the number or percentage of a given group of subjects incorrectly responding to a specific item on the program. A high degree of error would probably indicate a need for revision in the program.

EXTRINSIC PROGRAM - Synonymous with the term, "linear program."

FADING - A technique used in programing; the gradual withdrawal of stimulus support. Fading can be done in intact units (all materials to be faded can be dropped out at the same time) or portions can be faded progressively. This technique lends itself especially to material where visual discriminations are important. Example: map reading.

FEEDBACK - The function of a teaching machine which consists of providing the pupil with "knowledge of results."

FORCING - The presentation of subject matter in such small steps as to assure a correct response by the learner.

FRAME - A unit of a program: The segment displayed at each step in the sequence. Usually the unit that requires a response.

FRAME, FORCED - A stimulus frame presented to the student forcing him to respond correctly by obvious nature of the answer.

FRAME, TERMINAL - A frame having no prompts located at the end of a sequence to test whether the student has reached "terminal behavior."

HARDWARE - Slang term referring to mechanical teaching devices.

INTRINSIC PROGRAMING - (See: BRANCHING).

ITEM - Any single unit of a test or experiment - e.g., a single question on a test or a single nonsense syllable in a list of syllables.

ITEM, AUGMENTING - An item supplying new information but not requiring the student to make a relevant response.

ITEM, DELAYED REVIEW - An item which allows for the distribution of practice. Differs from other items only in terms of presentation.

ITEM, DOVETAILING - An item requiring the student to make separate responses to separate stimuli which otherwise may become confused.

ITEM, FADING - An item requiring the student to review what has been presented. In addition, the item withdraws information successively. Similar to Skinner's "vanishing technique."

ITEM, GENERALIZED - Items which summarize the common characteristics of several specific items already presented to the student. E. G. after learning in previous items that "I, you, he," etc. are pronouns, he is given the problem "all words which are used in place of a noun are called _____."

ITEM, INTERLOCKING - An item that requires a student to review the established skills while new information is being presented.

ITEM, LEAD-IN - An item not requiring new information or rehearsal of the skill where a problem is restated.

ITEM, RESTATED REVIEW - An item requiring a rehearsal of the skill where a problem is restated.

ITEM, ROTE REVIEW - An item presenting a problem identical to one presented earlier.

ITEM, SPECIFYING - An item which exemplifies a general rule or principle.

ITEM, SUBJECT MATTER - An item classified with respect to its subject matter content.

ITEM, TAB - A specialized term referring to having the subject pull a tab to indicate his response rather than writing out an answer or selecting a choice.

LEADING - The student is first asked to talk about familiar things using his everyday vocabulary. He is then led to discuss relations among these. Technical terms are then slowly inserted.

LIBRARY UNIT - A component in a teaching machine used to store the program. The selector unit picks items to be presented from the library unit.

LINEAR PROGRAM - A program which has a single, predetermined sequence of steps. Error responses are not corrected or immediately repeated. A drop-out device can be incorporated into the machine whereby errors may be reviewed at the end of the set sequence.

MATCHING - Procedure used in some Skinner machines to inform student of correctness of his response. After writing his response, the student moves a lever which exposes the correct answer with which the student compares or "matches" his response.

MATHETICS - An approach to programing designed by T. F. Gilbert. It is an attempt to establish a set of rules or guidelines for analyzing and writing programs.

MIN-MAX - (minimum complexity - maximum function). The trade name of a teaching machine distributed by Grolier, Inc.

OBJECT-DESCRIPTIVE METHOD - A method of sequencing material in a program in which a complete object is presented and the different components of interest are pointed out or to be identified. (This is in contrast to the class-descriptive method.) Example: The word "dime", the tail, head, and side view of a dime all presented in one display.

OBJECTIVE - An objectively defined goal toward which instruction is directed. The pupil is expected to reach this goal by the end of the instructional unit. Example: A "driver education" course may have as an objective: To qualify for a driver's permit by passing, with a score of at least 70%, a true-false and multiple choice test on road signs and rules.

OVERPROMPTING - Undesirable feature of some programs in which a text of frames has an excessive number of prompts. The student is likely to become overly "dependent" on program-supplied responses, making weaning more difficult.

PACE - The rate at which the subject is permitted to work through the programed material. (The pace may be determined by the learner or by a pacer.)

PACE, PACING - Time intervals in instruction. Two crucial intervals are: (a) between presentation of a cue or question and presentation of the correct information or answer, and (b) between one cue or question and the next. (see PACING, SELF).

PACED-PRACTICE MODE - A mode of operation of a teaching machine in which a timer limits the time durations. Example: The time of presentation is limited, or the time for a response is limited.

PACER - 1. Component of a teaching machine which limits the time intervals (a) between presentation of a cue or question and the presentation of the correct information or answer and/or (b) between one cue or question and the next.

2. A type of stimulus-response device which presents stimulus materials for a given interval of time and then provides the appropriate response, whether or not the learner has attempted to answer. Example: Memory drum.

PACING, CONTROLLED RATE - Control of the subject's rate of responding by features of the mechanical device utilized to present the program.

PACING, SELF - The rate at which the subject might complete the material at his own rate depending upon success on the previous steps.

PANEL - A short passage of prose material, graphs, and similar material which are presented or studied along with the discs in the Skinner device.

PANEL (EXHIBIT) - Supplementary display of information to be referred to the pupil as he responds to a set of frames.

PRACTICE MODE - A mode of operation of a teaching machine in which the student continues to make responses to a frame until he makes the correct response. After each response the student is told whether he is correct or not. (see also: CORRECTION PROCEDURE).

PRESSEY DEVICE - The earliest knowndevice (1926) originally developed for use with multiple choice tests. Device could be set so that items missed could be skipped or repeated until success was established, a raw score obtained, and an items analysis or error count secured.

PREVERBAL MACHINE - A machine which presents frames in the form of pictures or figures which may be matched or contrasted; no words are used in the frames presented. Such programs can be used with pupils of pre-reading age.

PROGRAM - An arranged set of frames in a given subject.

PROGRAM, EXTRINSIC - A term usually applied to Skinnerian (linear) programs. The program proceeds in small steps from simple levels to complex levels in a predetermined order of frames.

PROGRAMED BOOK - A special book in which the subject matter to be learned has been arranged into a series of sequential steps leading from familiar concepts to new materials. Differs from a "scrambled textbook" in that the content is arranged so that the student proceeds directly from one step to the next, or one succeeding page to the next, rather than skipping around. The student generally is asked to construct a response as opposed to choice.

PROGRAMED TEXTBOOK - A book requiring the learner to construct responses to the systematically arranged materials. It follows the linear approach (Skinner). Example: Page 1 gives the stimulus and requires a constructed response while page 2 gives the feedback (reinforcement) and presents a new stimulus requiring another constructed response. . . . and on to page 3.

PROGRAMING - The process of arranging the material to be learned into a series of sequential steps; usually moves the student from a familiar background into a complex and new set of concepts, principles, and understandings.

PROGRAMING, INTRINSIC - A method of programing materials that directs the erring subject along certain corrective pathways before he is permitted to proceed to the next step in the program. Requires that each step contain multiple choice answers.

PROMPT - Programing techniques designed to insure the desired response to a frame.

PROMPT, EMPHASIS - One of the cues or stimuli employed for insuring correct responses. An emphasis prompt is usually an underlined word or phrase written in CAPITAL LETTERS to give it emphasis. Example: (a) Paris is the capital of France. The capital of France is _____.

PROMPT, FORMAL - A prompt which provides the pupil with cues to the appearance of the required response: i.e., the way the response "looks." Example: "The capital of France is P _ _ _ S." The "P", the number of dashes, and the "S" are formal prompts.

PROMPT, SEQUENCE - One of the cues employed for insuring correct responses. The sequence prompt may be one of two formats: (a) If a pupil reads a text in one item and gives one of the words in the next item, the sequence prompt is a function of what the student had just read or seen. (b) If a student copies a model in one item, and repeats the response without a model in the next item, the sequence prompt is a function of what the student had just written or produced.

PROMPT, THEMATIC - A prompt which depends for effect upon previous associations in the pupil's repertoire. Example: CANIS FAMILIARIS is a man's best friend. CANIS FAMILIARIS is the technical name for the animal commonly called a _____. The phrase "man's best friend" means dog to most people. The phrase"man's best friend" is the Thematic prompt.

PROMPTING - The method or sequence of providing verbal and symbolic cues to encourage responses. Can be visual, verbal, symbolic, or auditory.

PUNCHBOARD DEVICE - A unit containing rows of holes to use in selecting a multiple choice response. The student punches through a paper with a pencil or stylus. If correct, the pencil goes completely through the paper. If incorrect, a backing plate prevents the pencil from going completely through.

PURE-PART METHOD - A method of sequencing programed instruction in which each part is first learned separately to a criterion of mastery. Subsequently the parts are repeated until the whole has been brought to the criterion already achieved by each part.

"QUICKENING" PROCEDURE - Giving the student knowledge of the results of his response while he is still in the process of making the response. Example: After writing the first one or two letters of a response word, the student would be told he is incorrect.

QUINTAIN - Known as a medieval teaching machine used to train knights. The appropriate response was to strike a shield directly in the center with a lance. If it struck off center, the device would deliver feedback by striking the horseman a blow as he rode by.

RECYCLING - A machine function which returns the student to a previous part of the program.

REINFORCEMENT, MECHANISM - Some type of reward for responding correctly to the items in the display. A motivational factor causing the individual to keep working at the set of materials. Sometimes considered as an integral part of the confirming mechanism.

REINFORCERS, PRIMARY - A class of stimuli which will, without any prior history of training, reinforce operant behavior.

RELATIONAL GUIDANCE - A technique used when a principle is to be applied in a variety of contexts, each requiring a different objective response.

RESPONSE MODE - The kind of response the pupil makes while working on a program. Examples: writing the answer, pushing a button, pressing a panel, etc.

ROTE REVIEW - Repetition of a frame presented earlier in the program. This type of presentation is useful mainly where sheer memorization of verbal material is desired. Such items are usually presented out of sequence.

RULEG - A system in programing which consists of a statement such as a rule, principle, or definition - followed by one or more examples. The statement and examples may occur in the same frame; or in a series of frames.

SCRAMBLED BOOK - (see: SCRAMBLED TEXTBOOK).

SCRAMBLED TEXTBOOK - A programed textbook arranged according to the branching method of programing. If a correct response is made to a question, the learner is referred to a page in the book which confirms his response and moves him on in the program. If the response is incorrect, he is referred to another page, which gives him remedial attention. Eventually he is returned to the question that he missed, and he tries again. Since the pages aren't taken in order, it is called a "scrambled textbook." Each frame is a multiple choice, each of the several answers directs the student to a different page.

SEEDING - Inserting review materials at intervals in a program. These reviews may be either regularly spaced (periodic) or, irregularly spaced (aperiodic).

SELECTOR UNIT - The component of a teaching machine which compares the pupil's response with the correct response.

SEQUENCING - Arranging the frames of a program in an order that provides the most efficient situation for learning.

SET - A series of frames in the program dealing with one information unit.

SHAPING - The building of a behavior or set of behaviors through the differential reinforcement of progressively more adequate forms of behavior. (Skinner).

SIMULATOR - A type of stimulus-response device which duplicates the essential characteristics of some complex task and which requires appropriate action from time to time on the part of the learner. Ordinarily, this type of device does not provide immediate feedback. Example: Electronic simulator.

SINGLE-ERROR-PERMITTED MODE - A mode of operation of a teaching machine in which the student makes a single response to a frame. Then he is told if the response is correct or not, and if the response is incorrect he is shown the correct response.

SINGLE-TRY MODE - A mode of operation of a teaching machine in which the pupil is allowed only one response to each frame. The next frame is presented whether the response was correct or not.

SKINNER DEVICE - A mechanical device which presents a set of programed materials. At each step, the subject must construct an answer and evaluate its correctness with a model answer before proceeding further in the program. Generally considered, the forerunner of later model "teaching machines."

SKINNER DISC - A round, flat, recordlike device which contains a set or series of program materials for the Skinner device. Contains the questions to be answered, spaces for recording student's answers and the correct response, as well as for making a record of successful or unsuccessful performance.

SKIPPING - Termination of program prior to the final item of a subset and going to the next topic. If the student's response is correct on a key frame, the student is directed to the next set, he "skips" a portion of the program.

SOCRATIC METHOD - A method of instruction which consists of a conversational quiz in which a tutor asks questions, the student replies, and the tutor confirms or denies the answer. If a response is incorrect the tutor leads the student by a series of questions to the correct response.

SPECIFYING ITEMS - Items which exemplify a general rule through specific examples, e.g., after a student has been told that the symbol $\div$ means "divided by" he is given a problem $4 \div 2 =$ _____. Response to this item is 4 divided by 2.

STABLE SEQUENCE - Refers to the sequence in a serial-learning task, such as learning the letters of the alphabet. It is stable because the order of stimuli and responses remain fixed and predictable.

STEP - The increment in subject matter level to be learned with each succeeding item or frame in the program.

STEP SIZE - Average amount of difference between successive frames. A function which is inversely proportional to the number of frames in an instructional unit.

STICK, HICKORY - The original teaching machine.

SYNCHRONY - Both stimuli and response change from item to item in the series, or neither the stimulus nor the response change from item to item. Example of the latter type is repetition.

TEACHING AIDS - Devices useful in the teaching process which do not assure learning either because they do not necessarily require any action on the part of the learner when presented with the subject matter or permit him to practice some activity but do not necessarily provide him with subject matter on which to practice.

TEMAC - A brand name for a programed text produced and sold by Encyclopaedia Britannica Films, Inc.

TERMINAL BEHAVIOR - The behavior a program is designed to produce. (See: OBJECTIVES).

TEXT MODE - An operational mode of a teaching machine which will provide the display unit, the response unit, and the program, but will not provide feedback to the student. E.g., Pressey's Drum Tutor as a testing device.

TRACK, MULTIPLE - A provision within the programed material for allowing subjects to pursue alternative sub-divisions of the program in terms of their successes or failures with earlier sections of the sequence. (See: BRANCHING).

TRACK, SINGLE - A common set of programed materials which all subjects work through, there being no alternative program such as in the multiple track situation. (See: LINEAR).

UNSTABLE SEQUENCE - Refers to the arbitrary and unpredictable order between items in a paired-associates learning task such as learning a French-English vocabulary. (See: STABLE SEQUENCE).

VANISHING - A form of fading in which the prompt is gradually removed by making it progressively less discriminable.

WEANING - Behavioral goal of the fading technique. Training the pupil to make "independent" responses to stimuli which were previously accompanied by prompts.

(B) Programed Instruction and Teaching Machines

ACQUISITION - See TERMINAL BEHAVIOR.

ADAPTIVE TEACHING MACHINE - See TEACHING MACHINE.

AUTO-INSTRUCTIONAL DEVICES - (1) Machines and technological systems devoted to mass instruction, including various applications of television and the massed film systems, such as EBF's physics and chemistry series. (2) Also systems and machines for individual instruction including the individual reading pacers, individual viewing and listening equipment, language laboratories, programed printed materials, and the true teaching machine of the Skinner or Pressey type which presents verbal and pictorial programs in various ways, electronic and mechanical, so that the individual responds and is informed of errors and progress (Finn).

AUTO-INSTRUCTIONAL METHODS - Synonymous with programed instruction, programed learning, automated teaching, self-instructional materials, etc. The term auto-instructional was proposed by Lumsdaine and Klaus to circumvent the "misleading, prejudicial, or both" connotations they attributed to the other labels. The teaching machine is an auto-instructional device (AID).

AUTOMATIC TUTORING - The term for programed instruction most frequently used with intrinsic programing.

BRANCH - A point of choice at which students are sent to alternative items depending on their responses to the particular item. A common use of branching is in intrinsic programs, where the branch (or loop) consists of a single item explaining why a particular answer is incorrect and returning the student to the original item for another try. A criterion item may be inserted in a linear program, and, if the student passes it, he is sent forward several items (FORWARD BRANCHING); if he fails the criterion item, he takes an intervening sequence of review or remedial items. A student may, at a criterion item, be sent backward in the program to repeat items he has already seen but has inadequately mastered (BACKWARD BRANCHING or WASH-BACK). Students may be branched on the basis of either constructed responses or multiple-choice responses, although the latter predominate.

CHAINING - The linking together of a series of discriminable responses in a particular order. The completion of the first response . . . provides the stimulus for the second response. In typical laboratory examples, reinforcement is given at the end of the chain of responses. A classroom parallel can be

seen in the solution of a long-division problem: each step in the procedure could be separately taught, even in a random order, but the final performance requires a prescribed order to achieve the solution. To provide a student KNOWLEDGE OF RESULTS (q.v.) at the end of the solution sequence parallels the provision of reinforcement following the final response in a chain.

COMPOSED RESPONSE - See RESPONSE, CONSTRUCTED.

CONVERSATIONAL CHAINING - A programing technique in which the correct answer to an item is not presented by itself but is rather embedded in the text of the following item. Consecutive items are thus closely linked by the necessity of repeating in the new item the word or words that were elicited in the previous item. The response to one item becomes part of the stimulus in the next. The technique was developed and described by John Barlow. Also see CHAINING.

CRITERION - See TERMINAL BEHAVIOR.

CROWDER-STYLE PROGRAM - See PROGRAMING, INTRINSIC.

CUE - See PROMPT.

ERROR - A response not acceptable to the programer. Programers attempt to eliminate errors by revising the program. Erroneous responses may indicate: (1) A poorly designated item which fails to communicate and therefore needs to be rewritten; (2) a sequence in which prompts have been faded too fast or inadequate practice given: (3) assumed previous knowledge which in fact the student does not have; (4) poor analysis of the subject matter, leading to a confusion not predicted by the programer. Intrinsic programs handle errors by branching students to simpler presentations (type 2) or to remedial sequences (type 3). Linear programs are revised to prevent such errors. Errors due to sources (1) and (4) are unacceptable to programers and teachers alike.

Confusion has been introduced by assumptions that the principle of errorless learning means that all responses must meet a criterion of unvarying precision. False starts such as a blind alley in trouble-shooting or problem-solving, a tentative generalization based on inadequate data, an over- or under-estimation in approximation, etc., are mistakes which may be valuable for training purposes.

ERROR RATE - Generally, the percentage of incorrect responses on an item, a set of items, or a whole program. A relatively low error rate - though programers do not agree on the range that is low - is a necessary but by no means sufficient condition for a program to be considered acceptable. Spuriously

low error rates are too easily attained by adding irrelevant easy items, testing with a pretrained population, removing terminal items, etc.

FADING - The gradual removal of the prompts in a sequence of items teaching a particular topic. Sequences typically begin with highly prompted items and end with unprompted terminal items. The word is sometimes used as a synonym of vanishing.

FEEDBACK - A term borrowed from communication theory, it describes an occurrence resulting from or contingent upon the student's response. It is not necessarily synonymous with reinforcement, since it is not defined by its effect on the recurrence of the response.

In a trouble-shooting program, for instance, the response might be, "I choose to measure A." Feedback would be, "The value of A is X." The feedback does not indicate necessarily the rightness or wrongness of measuring A. (See KNOWLEDGE OF RESULTS.) A distinction is made by intrinsic programers between providing the student the correct answer, as is typical in linear programs, and providing a more extensive discussion of why the answer is correct as is sometimes done in intrinsic programs. The discussion is the feedback.

FORMAL PROMPT - See PROMPT.

FRAME - See ITEM.

GROUP PACING - See PACING.

ITEM - A segment of material which the student handles at one time. An item may vary in size from a single incomplete sentence, question, or instruction to perform some response, up to a sizable paragraph. In almost all programing methods, it will require at least one response and will provide for knowledge of results before the student proceeds to the next item.

KNOWLEDGE OF RESULTS - A report to a student on the status of the response he made. It may be a verbal report, "Right" or "Wrong" (or lights, buzzers, etc., signaling one of these results), or a display (oral or written) of the correct verbal response. It may be a response of manipulandum, particularly in those cases in which the operation of a device is the subject matter. Some teaching machines advance to the next item only when the correct response has been given. Since knowledge of results has been shown to facilitate learning in many situations, it is generally considered a sub-class of reinforcement.

MACHINE PACING - See PACING.

PACING - In programed instruction, the rate at which the student proceeds through a given number of items. The usual procedure is self-pacing: the student reads and responds at his own rate. A stimulus device such as a film may be adapted to perform stimulus-response functions. If materials are presented by such a device to a group, the time allowed for input and for response must be standardized (through) group-pacing. A few devices, such as reading accelerators, control the individual student's pace by machine-pacing, moving on to the next item irrespective of the student's behavior.

PANEL - A section of material available to the student while he is working through more than one item; the section may include texts, diagrams, maps, globes, and laboratory equipment. . . . In a programed textbook . . . a panel is a single level in the horizontal format. Thus, such a text may have three panels on a page - levels A, B, and C.

PRESSEY DEVICE - A multiple-choice device dating from the 1920's which presented questions either on a rotating drum or on separate sheets. The student selected an alternative and pressed a corresponding key. The machine was coded so that if the student's response was correct, the device advanced to the next question; if the response was incorrect, an error was tallied, and the device remained set for the question until the correct response was given.

PROGRAM - A sequence of carefully constructed items leading the student to mastery of a subject with minimal error. The distinguishing characteristic of programed materials is the testing procedure to which they are subjected. Empirical evidence of the effectiveness of each teaching sequence is obtainable from the performance records of students. See also PROGRAMING, LINEAR and PROGRAMING, INTRINSIC.

PROGRAMED INSTRUCTION - The utilization of programed materials to achieve educational objectives. Synonymous with auto-instruction, automated teaching, etc.

PROGRAMED TEXT - A book in which a program is printed in one of two typical formats: page-to-page or down-the-page. In the first type, the student turns the page after each item, finding the answer and the next item on the following page. Generally, items are arranged in levels. The student goes through the book doing all the items on one level, then repeats the process for each successive level. A down-the-page format requires the student to mask the answer column and in some cases everything but the item he is working on as he reads down the page. A programed text almost always presents a linear program. See SCRAMBLED BOOK.

PROGRAMER - The person responsible for the design of items and sequences in a program. The programer may be a psychologist working with a subject-matter expert who delineates the content, or he may be a subject-matter specialist trained in programing techniques.

PROGRAMING, ECLECTIC - Programers not committed to a particular school of programing. The resulting programs may contain ruleg and egrul sequences, multiple-choice and constructed-response items, branches and linear sequences.

PROGRAMING, INTRINSIC - A programing technique developed by Norman Crowder, characterized by relatively lengthy items, multiple-choice responses, and consistent use of branching. If, after reading the information section of each item, the student selects the correct response to the question based on the material, he is sent to an item presenting new information. If he selects an incorrect alternative, he is sent to an item which provides information as to why his choice was incorrect. To the extent that the programer has correctly predicted the possible response that the student population will make, the program taken by each student is under the control of his own responses, and will differ for students of differing abilities.

PROGRAMING, LINEAR - A programing technique developed by B. F. Skinner. Set sequence of items presents information in small units and requires a response from the student at each step. The steps are so designed that errors will be minimal for even the slower students in the target population. Every student does each item in the program, his progress differing only in the rate at which he proceeds through the sequence. Constructed responses are demanded of the student most of the time.

PROMPT - A stimulus added to the terminal stimulus to make the correct response more likely while the student is learning. It may be pictorial or verbal. Prompts vary in strength, i.e., in the probability with which they will evoke the correct response from a given population. The term is used synonymously with cue and is generally synonymous with the nontechnical term hint. Prompts were classified by Skinner into two major types: Formal prompts provide knowledge about the form of the expected response, such as the number of letters, the initial letter, or the sound pattern (prompted by a rhyme); thematic prompts depend on meaningful associations which make the student likely to give the expected response.

A distinction between prompt and cue is made by some writers. Prompt describes the function of a model of the response which the student copies, while a cue is a hint of a weaker sort. (Skinner specifically excluded from the category stimuli to be imitated.) This usage of the term parallels the laboratory technique of response prompting, in which a student is given a stimulus (a word or picture), is told the correct response (prompted), and repeats the response after the prompter. Note: Since one use of the term specifically excludes that which the other use of the term includes, readers must determine which sense the author intends before interpreting one set of results as being in conflict with another.

RATE - See PACING.

REINFORCEMENT - A technical psychological term that denotes a process in which some stimulus, presented immediately following a response, increases the rate at which the response is emitted in a standard situation or which increases the probability that the response will recur when the situation recurs. A stimulus having such an effect is reinforcing or is a reinforcer. Knowledge of results (feedback or confirmation) has been shown to reinforce correct responses of students in many learning tasks. When the student's correct response is followed by presentation of the correct answer, the probability that the correct response will recur is increased. When correct responses are not followed by knowledge of results, and when the student has no other way of determining what is correct, learning may not occur. . . . The correct answer is a reinforcer. Considerable confusion has arisen because stimuli such as food, praise, or money are sometimes called reinforcers even in situations where they are not effective, i.e., no learning occurs when they are present or the same learning occurs even when they are not present. Experimental findings suggest that presentation of the correct answer may not be operating as a reinforcer in programed instruction. Learning has been shown to occur without confirmation of correct responses. The extent to which the correct answer may truly be called a reinforcer remains to be demonstrated. NOTE: Educators should be aware that the psychological use of the term reinforcement does not parallel their own use of it. The two definitions are quite distinct. In both cases, a response is strengthened, but the procedures differ. In educational parlance, repetition or rehearsal is the procedure denoted by reinforcement.

RESPONSE - A technical psychological term that designates a wide variety of behavior. It may involve the production of anything from a single phoneme or letter, word or phrase, to the solution of a problem requiring an hour or more. It may involve selection among alternatives (multiple-choice) in which case the response often includes the non-verbal manipulation of buttons, keys, etc.

RESPONSE, CONSTRUCTED - A student's effort to complete a sentence, solve a problem, or to answer a question. A model of the response may be provided for the student to copy, but as long as he writes, says, or thinks it rather than selecting it from a set of alternatives, the response is constructed.

RESPONSE, COVERT - An internalized response which the student presumably makes but which is neither recorded nor otherwise available to an observer. A student who is producing an oral or written response must think of the response (i.e., respond covertly) before producing it. Experimentation is underway to determine the relative contributions of the covert and the overt components of responses in varied programs and with students of various ability levels, etc.

RESPONSE DEVICE - See TEACHING MACHINE.

RESPONSE, MULTIPLE-CHOICE - The student's selection of one out of two or more alternatives. . . . The provision of the correct answer among the alternatives prevents him from responding in his own words but does not necessarily produce a smaller step nor an easier item than some constructed-response items. The provision of incorrect alternatives, Skinner argues, may "strengthen unwanted forms of behavior," i.e., the student may retain the erroneous information despite the provision of knowledge of results (q.v.). Where the desired behavior is a selection of or a discrimination between alternatives, the multiple-choice item seems the more efficient training and testing technique.

RESPONSE, OVERT - A student's oral, written or manipulative act which is, or can be, recorded by an observer. Whether such responses contribute significantly to learning or not, they provide the data on the basis of which programs are revised.

RESPONSE, PASSIVE - Synonymous with RESPONSE, COVERT (q.v.).

RESPONSE PROMPTING - See PROMPT.

RULEG - The systematic technique for construction of programed sequences developed by Evans, Glaser and Homme: All verbal subject matter is classified into (1) RU's, a class including definitions, formulae, laws, etc.; and (2) EG's, a class including descriptions of physical events, theorems, statements of relationships between specific objects, etc. The latter provide examples (EG's) of the former class of statements. With this classification scheme, the authors recommend that programers introduce new information according to the formula "RU, EG, incomplete EG," the student's response being the completion of the incomplete example, for instance, the student could be given a spelling rule and a correctly spelled example of it, and be required to spell a second

such word. The advice has caused controversy. Some programers prefer an inductive approach, leading the student through a seri s of examples (EG's) before having him formulate the RU himself. This approach has been tagged EGRUL.

SCRAMBLED BOOK - A book which presents an intrinsic program. Following the information presentation, a multiple-choice question is given. The answer the student selects refers him to a particular page for confirmation or correction. He may be sent either forward or backward in the text, the number of pages in either direction being randomized. Thus, no clue to which alternative is correct can be found in the page reference accompanying each alternative.

SELF-PACING - See PACING.

SHAPING (noun) - A training procedure in the psychological laboratory. To shape a complex performance, the trainer begins with some response the animal is likely to make that is somewhat similar to or that is a small component of the desired terminal performance. The criteria for reinforcement are gradually shifted toward the complex behavior. For example, if the turning of a full circle is the terminal behavior, the trainer might reinforce a head motion as a first approximation, then wait until a step accompanies the head motion before delivering another reinforcement, then wait two steps, etc., until finally the animal is turning a full circle. Parallels are drawn between this training procedure and programed sequences which begin with copying behavior and more through highly prompted items through fading to the final criterion performance.

SKINNER DEVICE - Any one of a class of devices providing a small space for presentation of information, a small space for the student to write his response, and a mechanism to reveal the correct answer for his comparison after he has responded. The original model presented material printed on a disk (hence disk became synonymous with lesson), one segment or frame of which was visible at the time. When the student exposed the correct answer, his response was simultaneously shielded under a transparent mask to prevent erasure. If the student scored his response as incorrect, the machine returned the item for a second try later. Items scored as correct dropped out. Present versions of Skinner-type machines lack this recycling feature.

SKINNER-STYLE PROGRAM - See PROGRAMING, LINEAR.

STEP - An indefinite, intuitive, but basic concept. A subject to be programed is broken down into items (steps). It is assumed that students cannot take later steps in a given

sequence before taking the early steps, and that each item represents a step forward. If students cannot respond correctly to an item, that item is considered "too large a step." The emphasis in linear programing is on small steps with a resulting low frequency of error. A step represents a combination of (1) A subjective judgment that an item represents progress in the student's mastery, and (2) An objective measure of the student's ability to respond correctly to the item. The size of the step is not necessarily related to the size of the response - a lengthy response may represent only a small step forward - nor is it necessarily related to the amount of material contained in an item. A programer generally increases the number of items to reduce the size of the steps.

STIMULUS - A technical term in psychology, it designates a class of events which impinge on an organism's sensory equipment and which experimenters can manipulate, describe, or hypothesize to exist. Stimuli are linked as observable (or hypothesized) antecedents to specific responses. In S-R (stimulus-response) psychology, the stimulus is a necessary antecedent to a response. Skinner's position places more emphasis on the consequent (reinforcing) stimuli than on the antecedents. In a program, the content of the item is the stimulus. This includes the terminal stimulus (the bare bones of the question or statement), any additional stimuli operating as prompts or models and any external material such as panels.

STIMULUS DEVICE - See TEACHING MACHINE.

STIMULUS-RESPONSE DEVICE - See TEACHING MACHINE.

STIMULUS, TERMINAL - The unprompted question, incomplete statement, or problem to which the student is taught to respond. This stimulus may occur as part of a prompted item which is not, therefore, a terminal item.

TEACHING MACHINE - A device that presents a program. Most machines control the material to which the student has access at any moment, preventing him from looking ahead or reviewing old items. Many machines contain a response mechanism: a tape on which the student writes, a keyboard, or selection buttons. Some provision is made for knowledge of results, either by revealing the correct answer after the student responds or by advancing to the next item, thereby signaling correct completion of the previous item. A few machines score the student's response and tabulate errors. Machines are being developed which will select the next step on the basis of the student's response. This type of machine, in combination with a branched program, comprises what Stolurow calls an ADAPTIVE TEACHING MACHINE.

In Porter's terminology, a teaching machine is a STIMULUS-RESPONSE DEVICE providing immediate reinforcement. Such machines are distinguished from (1) stimulus devices, such as films, phonographs, etc., which present information but make no provision for responses from the student, and likewise from (2) response devices such as typewriters which provide for practice but not for controlled input of information. A teacher may provide the missing half of either a stimulus device or a response device. See PRESSEY DEVICE and SKINNER DEVICE.

TERMINAL BEHAVIOR - The behavior the student is expected to have acquired at the end of a program or programed sequence. Evidence that such behavior has indeed been acquired is provided by successful responses to terminal items and/or by performance on a criterion test. The terminal items contain no prompts, and are placed far enough from the training sequences to measure more than immediate memory. Criteria vary in testing or programs as they do in any other learning situation. Criterion tests may involve multiple-choice items, fill-in items, essays, or performance of some other task. If given immediately after the learning sequence, it is a test of acquisition; if given considerably later, it is a retention test. Such tests may involve only the actual material explicitly covered in the learning sequence, or they may involve extension, generalization, or application of the learned material, generally called transfer.

THEMATIC PROMPT. - See PROMPT.

TRANSFER - See TERMINAL BEHAVIOR.

VANISHING - A term originally designating the removal of more and more of the components of a specific chain of responses. In an example from Skinner, a student might be asked in the first frame to fill in a few obvious letters in a poem, then more letters, then words, phrases, and whole lines. When all the components had been vanished, the student would be reciting the whole poem. The term is often used synonymous with fading, although the process of withdrawing prompts is not strictly parallel to the above process.

WASHBACK - See BRANCHING.

IX. Directory of Publishers and Manufacturers

Company	Address
A-Alpha Pattern & Manufacturing C.	2523 E. 4th Street, Los Angeles 33, Calif.
Accelerated Instruction Methods Corp.	179 N. Michigan Ave., Chicago 1, Illinois
Addison-Wesley Publishing Co., Inc.	703 Welch Road, Palo Alto, California
Allen, Layman E.	WFF 'N PROOF, Box 71, New Haven, Conn.
American Institute for Research	410 Amberson Ave., Pittsburgh 32, Pa.
American Management Association	1515 Broadway, New York 36, New York
American Teaching Systems, Inc.	12902 S. Broadway, Los Angeles 6, Calif.
The Anirama Company	385 East Green Street, Pasadena, California
Ann Arbor Publishers	711 N. University, Ann Arbor, Michigan
Appleton-Century-Crofts, Programming Department	440 Park Avenue So., New York, New York
Association Press	291 Broadway, New York 17, New York
Astra Corporation	31 Church Street, New London, Connecticut
Basic Systems Incorporated	2900 Broadway, New York 25, New York
California Test Bureau	Del Monte Research Park, Monterey, California 206 Bridge Street, New Cumberland, Pa. 916 Williamson Street, Madison 3, Wisconsin 1415 Slocum Street, Dallas 7, Texas
Center for Programed Instruction	365 West End Avenue, New York 24, New York
Central Scientific Company Division of Cenco Instruments	1700 Irving Park Road, Chicago 13, Ill.
Chandler Publishing Co.	604 Mission St., San Francisco 5, Calif.
Colortone	2400 17th St., N.W., Washington 9, D.C.
The Comparator Co.	P.O. Box 452, Petaluma, California
Coronet Instructional Films	Coronet Building, 65 E. South Water Street, Chicago 1, Illinois
Corrigan Communications, Inc.	1111 E. Ash Avenue, Fullerton, Calif. 8701 Adah Street, Garden Grove, Calif.
Craig Research, Inc.	3410 So. La Cienega Blvd., Los Angeles 16, Calif.
Dorsett Electronics	P.O. Box 862, Norman, Oklahoma

IX. Directory of Publishers and Manufacturers

Company	Address
Doubleday & Company	501 Franklin Avenue, Garden City, New York
DuKane Corporation	St. Charles, Illinois
Dyna-Slide Company	600 S. Michigan Avenue, Chicago 5, Ill.
Edex	809 San Antonio Rd., Palo Alto, Calif.
Ed-U-Cards Manufacturing Co.	13-05 44th Ave., Long Island City, New York
Education Engineering Associates	3810 Pacific Coast Highway, Torrance, Calif.
Educational Aids Publishing Co.	Carle Place P.O., Long Island, New York
Educational Developmental Laboratories	284 Pulaski Rd., Huntington, New York
Encyclopaedia Britannica Press	425 North Michigan Avenue, Chicago 11, Ill.
Entelek, Inc.	42 Pleasant Street, Newburyport, Mass.
E-Z Sort Systems, Inc.	45 Second Street, San Francisco 5, Calif.
Fearon Publishing Company	828 Valencia Street, San Francisco 10, Calif.
Field Enterprises Educational Corp.	Merchandise Mart Plaza, Chicago 54, Ill.
Foringer and Company, Inc.	312 Maple Drive, Rockville, Maryland
General Atronics Corp.	One Bala Ave., Bala-Cynwyd, Pennsylvania
General Education, Inc.	96 Mount Auburn St., Cambridge 38, Mass.
General Programmed Teaching Corp.	1719 Girard North East, Albuquerque, New Mexico
Ginn and Company	Statler Office Building, Boston 17, Massachusetts
Graficroll Systems, Inc.	12424 Lakeshore Drive, Lakeside, California
Graflex, Inc., Special Products & Services	Rochester 3, New York
Graflex Distributor: Newman Visual Education Inc.	1408 Division Avenue, S., Grand Rapids, Michigan
Gray Manufacturing Company	16 Arbor Street, Hartford 1, Connecticut
Hamilton Research Associates	Box 38, New Hartford, New York
Harcourt, Brace & World, Inc. Department of Programmed Instruction	750 Third Avenue, New York 17, New York
Harper & Row, Publishers, Inc.	Evanston, Illinois

IX. Directory of Publishers and Manufacturers

Company	Address
Hollins College	Hollins College, Virginia
Holt, Rinehart, & Winston, Inc.	750 Third Ave., New York 17, New York
Honor Products	19 Belmont St., Cambridge 28, Mass.
HRB-Singer	Science Park, State College, Pennsylvania
Hughes Aircraft Company	
	Videosonic Systems Hughes Aircraft Company P.O. Box 90515 Los Angeles 9, California
Hunter Manufacturing Co. Inc.	P.O. Box 153, Coralville Branch, Iowa City, Iowa
INRAD (Institute of International) Research & Development, Inc.	Box 4455, Lubbock, Texas
International Educational Systems	20762 Skouras Drive, Canoga Park, California
Instructive Devices	8545 Academy Station, Albany 8, New York
Irwin, Richard D. Inc.	1818 Ridge Road, Homewood, Illinois
Jensen, Gerald J.	1267 Wensley Avenue, El Centro, California
Koncepto-Graph Corporation	See Graflex
LaBelle Industries	8545 Academy Station, Albany, New York
Learning Incorporated	1317 W. Eighth St., Tempe, Arizona
Lord Products, Inc.	28 West 22 St., New York 10, N.Y.
The MacMillan Company	60 Fifth Avenue, New York 11, New York
Management Research Association	14 Hill Drive, Dune Acres, Chesterton, Indiana
Mast Development Co. Inc.	2212 E. 12th Street, Davenport, Iowa
McGraw-Hill Book Company	4655 Chase Avenue, Lincolnwood, Chicago 46, Ill.
Modern Teaching Associates	1926 E. Capitol Drive, Milwaukee 11, Wisconsin
Mono-Dyno Corporation	2129 Monroe Avenue, Rochester 18, New York
Multi-Matic Machines	6782 LaJolla Blvd., LaJolla, California
National Blank Book	2829 Water Street, Holyoke, Mass.
Newman Visual Education Inc.	1408 Division Ave., S., Grand Rapids, Mich.

IX. Directory of Publishers and Manufacturers

Company	Address
New York Institute of Technology	135-145 West 70th Street, New York 23, New York
Operant Associates	2836 Whitewood, Ann Arbor, Mich.
Prentice-Hall, Inc.	Industrial Department, Englewood Cliffs, N. J.
Programmed Teaching Aids, Inc.	3810 S. Four Mile Run Drive, Arlington, Va.
Publications Distribution Service	615 East University, Ann Arbor, Mich.
Ravin Publications	4215 Calavo Dr., LaMesa, California
RCA Educational Services Radio Corporation of America	Camden 8, New Jersey
Random House, Inc.	501 Madison Avenue, New York 22, New York
Rheem Califone Corporation	5922 Bowcroft St., Los Angeles 16, Calif.
Rider, John F. Publisher, Inc.	116 W. 14th Street, New York 11, New York
Roto-Vue	211 North 7th St., Room 1212, Holland Building, St. Louis 1, Missouri
Sackheim, G. I.	Division of Physical Sciences, Undergraduate Division, Navy Pier, Chicago 11, Ill.
Saunders, W. B. Company	West Washington Square, Philadelphia 5, Pa.
Science Research Associates, Inc.	259 E. Erie Street, Chicago 11, Ill.
Scientific Development Corp.	372 Main Street, Watertown, Mass.
Shaw Laboratories	21 Harriet Drive, Syosset, Long Island, New York
Sigma Press	2140 K. St. N. W., Washington 7, D.C.
Standard Projector and Equipment Co.	7433 North Harlem, Chicago 48, Ill.
Staten, J. B.	Box 44, Bay City, Texas
Stipes Publishing Co.	10-12 Chester, Str., Champaign, Illinois
Syncromat Equipment Corporation	156 W. Michigan, Jackson, Michigan
System Development Corporation	Santa Monica, California
Teaching Machines, Corporation	235 San Pedro, N.E., Albuquerque, New Mexico

Teaching Machines Corporation, a Division of Grolier Corporation, 575 Lexington Ave., New York 22, N.Y., was formerly known as Teaching Machines Incorporated.

IX. DIRECTORY OF PUBLISHERS AND MANUFACTURERS

Company	Address
Thompson-Ramo-Wooldridge	8433 Fallbrook Ave., Canora Park, Calif.
TOR-Education, Inc.	453 Main Street, Stamford, Conn.
Training Systems, Inc.	12248 Santa Monica Blvd, West Los Angeles, Calif.
Tutortape	770 Lexington Ave., New York, New York
United Sound Systems	5840 Second Boulevard, Detroit 2, Mich.
Universal Electronics Laboratories	510 Hudson Street, Hackensack, New Jersey
University Microfilms	313 N. First Street, Ann Arbor, Mich.
U. S. Industries, Inc. Educational Science Division	250 Park Avenue, New York 17, New York
Van Valkenburgh, Nooger & Neville, Inc.	15 Maiden Lane, New York 38, New York
Varian Associates	611 Hudson Way, Palo Alto, California
Webster Publishing Co.	St. Louis 26, Missouri
Welch Scientific Company	1515 Sedgewick St., Chicago 10, Illinois
Wiley, John & Sons	605 Third Avenue, New York, N. Y.
Young, Jay A., Kings College	Wilkes Barre, Pennsylvania

CHAPTER X

A. CRITERIA FOR ASSESSING PROGRAMED INSTRUCTIONAL MATERIALS

1962 Interim Report of the Joint Committee on Programed Instruction and Teaching Machines

American Educational Research Association

American Psychological Association

Department of Audiovisual Instruction, NEA

Prepared with the cooperation and support of the Educational Media Branch, U.S. Office of Education, under NDEA Title VII

The members of the AERA-APA-DAVI Joint Committee include Harry F. Silberman, Evan R. Keislar, Robert Glaser, and Arthur A. Lumsdaine, Chairman (American Educational Research Association); Richard S. Crutchfield, James G. Holland, and Lawrence M. Stolurow (American Psychological Association); and Jack V. Edling, Edward B. Fry, Wesley C. Meierhenry, and Paul R. Wendt (Department of Audiovisual Instruction, National Education Association). Helpful contributions were made to the preparation and review of the present statement by a cooperating committee of the American Society of Training Directors, whose members are Leonard C. Silvern (chairman), Robert L. Craig, Stanley L. Levine, Leonard Nadler, and Gerald H. Whitlock. Also contributing were several consultants and staff assistants, including Lloyd O. Brooks, Martin V. Covington, H. J. A. Goodman, Bert Y Kersh, Susan M. Markle, Ernst S. Rothkopf, and David G. Ryans. Further suggestions from program writers, publishers, or users are invited for the committee's use in the preparation of subsequent reports. This present article, as an interim report, can be interpreted as expressing a consensus of Joint Committee members rather than an official policy statement of AERA, APA, and DAVI.

This statement by the AERA-APA-DAVI Joint Committee on Programed Instruction and Teaching Machines is concerned with educational techniques

that are variously called "programed instruction," "auto-instructional" methods, and "programmed learning."

The present statement amplifies and extends the previous guidelines published in 1961 by the Joint Committee.[1] This report, like the previous one, is addressed primarily to the non-technical reader interested in the possible purchase of programs. It summarizes some basic aspects of the nature and current status of programed instruction, and also presents some suggestions and cautions concerning the assessment of programs.

A subsequent, more technical report will provide supplementary information and recommendations addressed to the technical specialist who is directly concerned with obtaining or interpreting quantitative data to indicate the effectiveness of programs in contributing to specified instructional goals.

Programed instruction. As used herein, programed instruction refers to the use of materials or procedures which incorporate an "auto-instructional" (or self-instructional) program. Such a program commonly attempts to provide conditions under which a student can learn something efficiently with little or no outside help. Current programs typically employ a pre-arranged sequence of material that is presented to the student one small unit at a time (e.g., a sentence or paragraph). Most programs require the student to respond actively at least once for each unit (or "frame") of material—for example, by composing or selecting an answer to a question. Programs also commonly provide prompt confirmation or correction, as the case may be, for each response the student makes. In some cases, the program is presented by a mechanism or device called a "teaching machine"; in other cases it is presented by a specially designed

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1. This earlier statement by the Joint Committee was published in 1961 in the July-August issue of the AV Communication Review, the September issue of Audiovisual Instruction, and the November issue of the NEA Journal, as well as in a number of other educational periodicals.

form of book.[2]

Some Basic Consideration Concerning Programed Instruction

With or without the use of "teaching machines" for controlled presentation of programs, individual instruction by programed materials offers a very important potential resource for education. Attention to the following guidelines is suggested, however, in order that the potentialities of programed instruction may be effectively developed and utilized.

Experimentation and planning for school use. Programed instruction represents a relatively new and thus far largely experimental resource for education. Experimental tryouts in schools, of both locally and commercially developed programs, is strongly encouraged. Wide-scale adoption of any particular program may well await the evaluation of one or more provisional tryouts of that program.

Curriculum planning. An important potential advantage of individual programed instruction is that abler learners can proceed at an accelerated rate through basic course material and thereby qualify sooner for advanced instruction. On the other hand, suitable programing may enable the slow learner to attain higher levels of proficiency than would otherwise be possible. Planning for adaptation of curricula to accommodate these possibilities needs to be undertaken as programed materials of demonstrated quality become available.

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2. Detailed information about the development of teaching machines and programed-instruction-instruction concepts up to 1960 is contained in the source book, Teaching Machines and Programmed Learning, edited by Lumsdaine and Glaser and published by DAVI (724 p.; $7.50). A briefer treatise is Teaching by Machine, by L. M. Stolurow, published in 1961 by the U.S. Office of Education and obtainable from the U.S. Government Printing Office (173 p.; 65 cents). Reviews of several more recent books on programed instruction may be found in professional journals such as Contemporary Psychology, published by the APA, and the AV Communication Review, published by DAVI.

Perfecting programs through tryout and revision. Programed instruction affords outstanding opportunities for perfecting instructional sequences through successive revision based on detailed records of student response to preliminary forms of a program. The development of high-quality programs will generally entail considerable effort and expense. However, if costs can be prorated over a large number of students, a greater research and development effort can be invested in a program than might otherwise be considered feasible.

Tests of program effectiveness. Although the content which a program is designed to teach may be inferred from careful inspection of the program itself, external evidence based on student performance is needed to demonstrate how well the program actually teaches. However, the value of a method of instruction can not be tested in the abstract. For example, evaluation of a particular textbook is not an assessment of the usefulness of textbooks in general. A properly constructed experimental tryout or field test of a program may provide an assessment of that particular program, but does not afford proof or disproof of the value of a general "method" of programed instruction.

Experimentation conducted thus far supports, the expectation that good programs, carefully developed, can significantly improve both the quality and economy of instruction. Whether any particular program will do so is subject to question until established by adequate tests of the program. Unfortunately, programs may be offered for sale that will fall short of the potential value of programed instruction—for example, because they have not been carefully developed through procedures that include sufficient tryout and revision to assure their effectiveness.

Some programs require a machine for their presentation, while some are available only in book form. Other programs are available in two separate versions, one in book form and the other for use with a machine. In any case, it should be emphasized that so-called teaching machines, in themselves, do not teach. Rather, the teaching depends on the program of instructional materials that may be presented by a machine. The comparative merits of machine and non-machine presentation of printed programs for use in schools is as yet an unresolved issue. Any advantage for machine over book presentation can not be tested in the abstract but would depend on the characteristics of a particular machine. Some machines have demonstrable advantages for certain uses, including research; and suitable machines are required for programs that utilize audio materials.

Machine characteristics. The variety of types of teaching machines continues to proliferate, with little standardization. In evaluating any make or model of teaching machine, a continuing necessity is thus to assess the number and quality of programs available for use in it. For some machines the user who has sufficient time and skill can prepare his own programed materials; for other machines this may not be feasible. With some machines, a program can be re-used indefinitely; for others a new copy of the programed material may be required for each student.

For many machines, mechanical dependability can not yet be taken for granted. As with any new mechanical device, potential purchasers of teaching machines are well advised to seek reliable information on how on how extensively the device has been used in schools, what maintenance problems have been encountered, and the extent to which parts and service are locally available at reasonable cost.

Availability of machines. Existing machines differ greatly in complexity and cost; prices for most of them range from a few dollars to several hundred dollars per machine. Any catalog of teaching machines is likely to be obsolete as soon as it is printed because the field is developing so rapidly. New machines appear, and some advertised models fail to get into production. Several dozen different machines are briefly described and illustrated in a 1962 publication by Finn and Perrin.[3] A number of these are commercially available at present. Others have been withdrawn from the market or were experimental models that have never gotten into production.

PROGRAMS

Availability of Programs

An increasing number of programs is becoming commercially available in a variety of subject-matter areas. Mere availability is no guarantee of quality, however. In addition, programs (as well as machines) are sometimes announced long before they are actually available; also, as noted above, some programs are in a format that can be presented only with a particular kind of machine.

A useful guide to available programs for school subjects is a 383-page government publication entitled Programs, '62.[4] This publication lists some programs reported to be commercially available by September 1962. These programs span the curriculum from elementary to college levels and cover a

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3. Finn, J.D., and D.G. Perrin. Teaching Machines and Programed Learning 1962: A Survey of the Industry. Occasional Paper No. 3, NEA Technological Development Project. Washington, D.C.: U.S. Government Printing Office, 1962 (Publication No. OE-34019; 85 p., 55 cents). See subsequent footnote concerning information presented in this report.

4. The Center for Programed Instruction, Inc. Programs, '62: A Guide to Programed Instructional Materials. Washington, D.C.: U.S. Government Printing Office, 1962 (U.S. Office of Education, Publication No. OE-34015; 383 p., $1.50). See following footnote concerning information presented in this report.

variety of subject matter, including language arts, mathematics, music, physical and biological sciences, social studies, and business education. The report cited includes descriptive information and one or more sample sequences from each program. Pertinent data given include the intended student population, the number of "frames" in each program, and its price, but no attempt is made to evaluate the programs.[5] It is anticipated that this compilation will be updated by similar guides for subsequent years.

Types of Programs

Programs are being produced in a variety of forms. Thus far they have tended to cluster around two or three main types; however, new variants or mixtures of types are also being introduced. The majority of current programs break the subject matter down into a large number of small steps or "frames," requiring the student to make one or more responses to each step. Such a program can be so designed that the student will respond to critical aspects of each frame or will get practice in performing the specific operation that each frame is meant to teach. Careful programing requires the programer to take great pains to insure that these steps embody a logical, well-sequenced progression of the subject matter. This applies especially to programs that are intended to serve as sole or independent sources of instruction rather than only as supplements to other material. Such programs often provide a number of examples to illustrate each principle, concept, or act that is to be learned.

Programs of the kind described above are designed to adapt to individual differences by allowing each learner to proceed at his own rate. In addition, some types of programs further adapt by providing for "branching" to alternate

5. The reports on devices and programs identified in the two preceding footnotes are cited solely for the convenience of the reader, and statements concerning them are not to be construed as an endorsement by the Joint Committee or its parent organizations, either as to completeness or accuracy of the information presented, or of the quality of the devices and programs listed in these publications.

materials. For this purpose, frames may include questions designed to diagnose the learner's needs, with directions taking him to alternate material suited to these needs.

In most of the current "branching" programs, the program is so constructed that the choice of a particular answer to a diagnostic question determines which frame will be presented next. Incorrect answers may take the student to frames containing information designed to correct the error before allowing him to continue through the sequence, or to frames that provide supplemental information or practice.

There is little empirical basis at present to favor one general type of program over another. It may be anticipated that different types of programs will eventually prove to be especially useful for particular kinds of educational purposes, and that different styles of programing may be combined effectively in a single program. At the present time, however, the general pattern of one type or another of programing may be superficially followed without necessarily capitalizing fully on its potential advantages.

CRITERIA FOR ASSESSING PROGRAMS

"Internal" and "External" Sources Of Information About Programs

A useful distinction can be made between "internal" and "external" characteristics which might serve as possible criteria for program evaluation.

"Internal" characteristics refer to features that can be revealed through visual inspection of the program. These include both the content of the program and the way the program is constructed. Content might be described in terms of relative emphasis given to various topics as well as general organization of the material. Descriptive characteristics of program construction might include information about the length of frames, use of branching sequences, techniques of prompting, patterns of repetition and review, modes

and frequency of response called for, procedures and scheduling of reinforcement, and the like.

"External" information about a program refers to features which cannot be observed merely by inspecting the program itself, such as the way it was developed and characteristics of its performance as a teaching instrument. External information of interest to a potential purchaser could include such things as the source of program content, qualifications of authors, history of the program's development, tryout and revisions, and test data indicating gains in achievement produced by the use of the program. This information, as indicated more fully below may be presented in a descriptive manual supplied by the program publisher.

Critical reviews of programs may furnish an additional basis for evaluation. Such reviews are beginning to appear in professional journals along with reviews of textbooks. (Some reviews include data on achievement attained by using the program as well as the reviewer's opinion about program content and style.)

Programs as Related to Textbooks and to Tests

The applicability of internal and external kinds of information as possible criteria for evaluating programs may in part be seen by comparing programs with textbooks and also with educational or psychological tests.

Programs as compared with textbooks. Both programs and textbooks may be inspected to determine what topics are covered and the relative amount of attention given to each. Such inspection would also indicate whether the subject matter is factually correct, whether it is current, etc. However, despite their similarities, programs differ from textbooks in several important respects that may affect their evaluation. A program's requirement for frequent student response generates a special source of data useful for

revising the program in detail. The tendency to empirically guided development of programs is coupled with an orientation toward testing the specific effects produced by a program, and toward more sharply focused objectives defined in terms of specified behavioral outcomes. In addition, the program is intended to generate a more predictable pattern of student behavior than does the study of a textbook, which generally has a less specialized purpose in aiming to serve as a reference source as well as a sequence of instruction.

Programs compared with psychological and educational tests. Although programs aim primarily to instruct students rather than to test them, programs and tests share some important attributes. Since both generate student-response data as an inherent feature, both tend to be developed in terms of empirical procedures. The difficulty of each item in a program, as in a test, can be investigated by presenting the program to appropriate samples of students and recording their responses. Both the program and the test have limited ranges of usefulness that can be described to the potential user in terms of empirical evidence; and in both cases it is possible to specify an external criterion to indicate the extent to which some intended outcome is achieved, as evidenced by the kinds of behavior that have been developed or differentiated.

B. Observations, Judgments, and Suggestions for Further Research

by C. R. Carpenter

Observations and Judgments

1) Programed content in mathematics and English grammar of adequate quality was organized and prepared in sufficient quantity, with a large enough number of comparable versions, to meet the research requirements.

2) The experiments were conducted with two samples of content which are generally believed to relate to different intellectual abilities - verbal and quantitative.

3) Generally, adequate numbers of student subjects were employed in groups of sufficient size, randomly composed, to meet the requirements of good experimental design.

4) Content was essentially constant for all versions, but formats were necessarily varied for the different media and methods compared.

5) The experiments were conducted in the context of academic curriculums and in learning environments where the usual demands, rewards, and penalties operated, using reliable tests which attempted to sample a wide range of learning performances.

6) The amount and kinds of content and the realistic context of the experiments, the controls and data analysis should permit reasonable generalization of the principal results for populations of students represented by the sample used in the research and for the sampled kinds and levels of academic study.

7) A principal result of the research was to show that the programed courses (as developed and administered) can be presented to students for study by the selected media and media combinations with approximately equal probabilities of learning gains.

8) Programed courses of good quality in the content areas sampled can be pre-paced and presented to groups of college and high school students without significantly reducing the learning that occurs under conditions of self-paced and individual study.

9) The main results of the experiments were consistent for the content areas of contemporary algebra and English grammar.

10) Programed content can be adapted and developed for effective presentation over closed-circuit systems when printed forms are used for learner responses and records.

11) Students from the populations samples have ranges of tolerances for pacing around mean frame-by-frame response cycle rates, and variations within this range do not significantly affect academic learning and attitudes toward programed material.

12) Students of the population sampled can study programed materials in interacting pairs and in classes of different sizes with learning comparable to that which occurs under conditions of individual study. The pairing technique is promising as a means of providing immediate social reinforcement in the study of programed materials.

13) Preliminary experiments suggest that programed courses which are well prepared, carefully administered, and mediated by printed materials (in book or machine form), or by projectuals, film strips, or television, and which are supplemented by study guides and tests will provide conditions as favorable for learning as those found in classes personally taught by above-average instructors who use the same study guides and tests.

14) The results of the experiments suggest that ranges in achievement scores of students studying programed materials under several conditions are reduced as compared with variations in scores of students taught by good instructors, and that the differences occur mainly in the lower quartile range of the distribution of scores.

15) Students who work in pairs on programed content and who are learning-task oriented show no substantial correlations between a personality measure of dominance-submissiveness and achievement scores.

16) It is possible that the use of supplementary materials such as study guides or assignments, which were common to all groups, may have reduced the possibilities of obtaining differences between treatments. Since the courses being taught by programed materials were parts of the University's regular academic programs, the use of these supplementary exercises was considered necessary for adequate instruction.